Asynchronous announcements in a public channel

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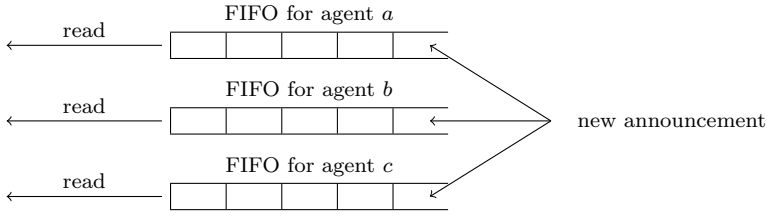
We propose a variant of public announcement logic for *asynchronous* systems. Agents do not all read the messages (logical formulas) at the same time, but they do read them in the first-in first out (FIFO) order.



1 Syntax

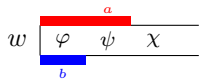
Sending and receiving messages are modeled by different modal operators:

- $\langle\psi\rangle\varphi$, which will mean "after the currently true formula ψ is (asynchronously) announced, φ is immediately true."
- $\bigcirc_a\varphi$ which will mean "after agent a *receives* the next announced formula in her queue, φ is immediately true."

For instance, $(p \wedge \neg \bigcirc_a \top) \rightarrow \langle p\rangle \bigcirc_a K_a p$ means 'if p is true and agent a has no message to read, then after p is announced, and after a reads its next message (which is p), a knows p'.

2 Global approach for the semantics

We consider an initial Kripke model that gives the knowledge agents have before the communication protocol starts. Then we define states as a given world w from the initial Kripke model plus a configuration of all FIFO queue for all agents. For instance, the state made up of a world w and a sequence $[\varphi, \psi, \chi]$ of announced formulas such that agent a has received φ and ψ but agent b only received φ is depicted as follows:



We evaluate formulas in such states. They should be consistent in the sense that announced formulas in the queue should have been true when they were announced.

3 Circularity problem in the semantics

Unfortunately it leads to a circular definition. For example, let us consider an initial model with a reflexive world w. Let us determine whether

$$w \boxed{} \models K_a p.$$

To this aim, we should see whether in all consistent states possible for a in states $w \boxed{}$, p holds. In particular,

$$w \boxed{K_a p}$$

is such a potential state possible for a and we need to check whether it is consistent. It is consistent iff

$$w \boxed{} \models K_a p.$$

So the definition is circular.

4 Results

To face the circularity problem, we describe two restricted cases in which we solve this problem. The first case requires the Kripke model representing the initial epistemic situation to be a finite tree, and the second one only allows announcements from the existential fragment. For instance, we can not announce $K_a p$ but we can announce $\hat{K}_a p$ (read as 'p is possible for agent a'). Finally, we provide PSPACE-completeness for the model checking problem. Details are in the paper:

Sophia Knight, Bastien Maubert and Francois Schwarzentruber. *Asynchronous announcements in a public channel.* ICTAC 2015.